Remarks

Claims 27 and 37 have been canceled. New Claims 51-64 have been added. Thus, Claims 22-26, 28-30, 32-36, 38-49 and 51-64 are active in the present application.

Applicant's undersigned representative thanks Examiner Wong for the careful examination of the previously pending claims and for the detailed explanations in the Office Action dated January 22, 2007. Applicant's position as to the remarks in the Amendment filed November 2, 2006 has not changed. However, in effort to advance prosecution of the present application and not belabor points already argued, the independent Claims 22, 29 and 32 have been amended to include a new limitation not disclosed or suggested by the cited references (namely, generating a quantizer scale for each object that provides coarser and/or fewer allowed quantization values for a high frequency subband than for a low frequency subband of the image sequence). It is sincerely hoped that the new limitation will be given fair and impartial consideration.

The present invention relates to a method for allocating bits to encode each frame of an image sequence, where each frame has a plurality of objects. The invention further relates to an apparatus for encoding each frame of such an image sequence, as well as a computer-readable medium having stored thereon a plurality of instructions which, when executed by a processor, generally perform the steps of the method. The method (as set forth in amended Claim 22 above) generally comprises:

(a) determining a target frame bit rate, T_{frame}, for the frame in accordance with a quantizer scale for each object in the frame;

(b) allocating the target frame bit rate among the plurality of objects in accordance with the formula:

$$V_i = K_i \times T_{frame}$$

where V_i is a target object bit rate for each object, and K_i is proportional to an average pixel value for the object;

(c) generating the quantizer scale for each of the objects in accordance with the target object bit rate, wherein the quantizer scale provides coarser and/or fewer allowed quantization values for a high frequency subband of the image sequence than for a low frequency subband of the image sequence; and

(d) recursively adjusting the target frame bit rate for each frame in the sequence.

In further embodiments, the present invention relates to a computer-readable medium (containing instructions generally to perform the present method; see amended Claim 32 above), and an apparatus for encoding each frame of an image sequence. The apparatus (as set forth in amended Claim 29 above) generally comprises:

(a) a motion compensator for generating a predicted image of a current frame;

(b) a transform module for applying a transformation to a difference signal between the current frame and the predicted image, where the transformation produces a plurality of coefficients;

(c) a quantizer for quantizing the plurality of coefficients with at least one quantizer scale; and

(d) a controller for generating the quantizer scale(s) for each of the objects in accordance with the target object bit rate, the quantizer scale(s) providing coarser and/or fewer allowed quantization values for a high frequency subband of the image sequence than for a low frequency subband of the image sequence, selectively adjusting the one quantizer scale(s) for a current frame in response to a target object bit rate for each of the plurality of objects, and determining the target object bit rate from a target frame bit rate in accordance with the formula:

$$V_i = K_i \times T_{frame}$$

where V_i is a target object bit rate for each object, and K_i is proportional to an average pixel value for the object.

The primary reference cited against the claims (Eleftheriadis et al., U.S. Pat. No. 6,055,330 [hereinafter "Eleftheriadis"]) does not disclose allocating a target frame bit rate among the objects in a frame according to ***an average pixel value*** for the object, nor does Eleftheriadis et al. appear to disclose the present step of generating a quantizer scale for each object that provides coarser and/or fewer allowed quantization values for a high frequency subband than for a low frequency subband of the image sequence (see amended Claim 22). While Eleftheriadis mentions the quantization of pixels and frames that comprise a plurality of objects, one benefit of the present claimed method is that the target bit rates can be prioritized based on the relative need of the objects for the available bits (as reflected by ***the average pixel value***) in a given application, rather than on the size of the objects. Furthermore, Eleftheriadis does not disclose a controller for generating such a quantizer scale and determining the target object bit rates from a target frame bit rate in accordance with an average pixel value for the objects (see Claim 29). Consequently, the present claims are patentable over the cited references.

One advantage of the presently claimed invention is that an object having a smaller number of pixels, but needing more bits (e.g., in terms of encoding syntax information, motion information and/or shape information; see, e.g., page 14, lines 2-7 of the present specification) can have a greater proportion of the available bandwidth, or target frame bit rate, than a larger object that does not need as many bits. In contrast, the approach of Eleftheriadis appears to assign a certain proportion of the available frame bandwidth based solely on the size of the object, without reference to the relative need for encoding bits by the various objects in the frame. The secondary reference, Klein Gunnewiek, fails to cure this deficiency.

Another advantage of the presently claimed invention results from quantizing high frequencies more coarsely and/or with fewer allowed values than low frequencies (see FIG. 6 and p. 20, ll. 14-29 of the present specification). Human perceptual sensitivity of quantization errors is generally lower for the higher spatial frequencies (p. 7, ll. 3-8 of the present specification). This is believed to enable one to use fewer bits and/or less computing power for encoding high frequency information, without sacrificing visual quality of the image sequence.

Neither Eleftheriadis nor Klein Gunnewiek disclose quantizing high frequencies more coarsely and/or with fewer allowed values than low frequencies or the possible benefits thereof.

Claim Rejections under the Judicially Created Doctrine of Double Patenting

In view of the new limitation added to each independent claim, the previous offer to file a terminal disclaimer to overcome the non-statutory double patenting rejection of claims 22-24, 27-34 and 37-38 is withdrawn. In particular, neither generating a quantizer scale for each of the objects in accordance with the target object bit rate, the quantizer scale providing coarser and/or fewer allowed quantization values for a high frequency subband of the image sequence than for a low frequency subband of the image sequence, nor any obvious variation thereof, appears to be recited in claims 1-13 of U.S. Pat. No. 6,023,296. Withdrawal of this ground of rejection is respectfully requested.

The Rejection of Claims 22-30 and 32-49 under 35 U.S.C. § 103(a)

The rejection of claims 22-30 and 32-49 under 35 U.S.C. § 103(a) as being unpatentable over Eleftheriadis (U.S. Pat. No. 6,055,330) in view of Klein Gunnewiek (U.S. Pat. No. 5,606,371) is respectfully traversed.

Eleftheriadis discloses a method and apparatus for performing digital image and video segmentation and compression using 3-D depth information (Title). In contrast to the present claims 22 and 32, which recite allocating the target object bit rate(s) in accordance with the target frame rate and ***an average pixel value*** for the object, Eleftheriadis appears to determine a target object bit rate based on a quantizer (the value of which appears to be related to the distance of the object from the camera; see, e.g., col. 11, ll. 1-15 and 41-44) and **the proportion of pixels in the object** (see, e.g., col. 11, l. 65-col. 12, l. 10; emphasis added). In fact, it appears that this point may be one on which there is agreement (see, e.g., pg. 6, lines 9-11, of the Office Action dated January 22, 2007). Thus, Eleftheriadis is deficient with respect to the present claims.

The disclosure of Eleftheriadis has been discussed at length in previous replies to Office Actions, and such discussions will not be repeated here. However, in addition to the above deficiency, Eleftheriadis does not appear to disclose generating a quantizer scale for each of the objects in accordance with the target object bit rate, the quantizer scale providing coarser and/or fewer allowed quantization values for a high frequency subband than for a low frequency subband of the image sequence (Claims 22 and 32) or a controller for doing the same (Claim 29).

Klein Gunnewiek discloses a device for encoding a video signal comprising means for dividing each picture into a plurality of sub-pictures, an encoder comprising a picture transformer for transforming each sub-picture into coefficients, and a quantizer for quantizing the coefficients with an applied step size (col. 1, ll. 5-10). Klein Gunnewiek neither discloses nor suggests allocating a target frame bit rate among the object(s) in a frame according to an average pixel value for the object, nor does Klein Gunnewiek disclose or suggest generating a quantizer scale for each of the objects in accordance with the target object bit rate, the quantizer scale providing coarser and/or fewer allowed quantization values for a high frequency subband than for a low frequency subband of the image sequence.

If there is a reasonable basis for interpreting either cited reference as disclosing a target object bit rate determined and/or based on ***an average pixel value***, Applicant's undersigned representative sincerely elicits an explanation of such basis. The constant values K_P and K_B of Klein Gunnewiek are not average pixel values, regardless of how they are applied in an equation. Instead, they appear to be related only to the gain of the encoder and the quantizer step size (col. 3, ll. 11-15, and col. 4, l. 44-col. 5, l. 10 of Klein Gunnewiek). Thus, the constant values K_P and K_B of Klein Gunnewiek are arguably not related to ***pixel values*** at all.

Thus, Klein Gunnewiek fails to cure the deficiencies of Eleftheriadis with respect to allocating the target frame bit rate among the objects in each frame in accordance with an average pixel value for the object, or generating a quantizer scale for each of the objects in accordance with the target object bit rate, the quantizer scale providing coarser and/or fewer allowed quantization values for a high frequency subband than for a low frequency subband of the image sequence, as recited in claims 22 and 32. Similarly, Klein Gunnewiek fails to cure the

deficiencies of Eleftheriadis with respect to a controller for doing the same, as recited in the present claim 29. Consequently, no possible combination of Eleftheriadis and Klein Gunnewiek can suggest the present claims 22, 29 and 32.

As a result, this ground of rejection is unsustainable, and should be withdrawn.

Conclusions

In view of the above amendments and remarks, all bases for rejection are overcome, and the application is in condition for allowance. Early notice to that effect is earnestly requested.

If it is deemed helpful or beneficial to the efficient prosecution of the present application, the Examiner is invited to contact Applicant's undersigned representative by telephone.

Respectfully submitted,

Andrew D. Fortney, Ph.D.
Reg. No. 34,600

401 W. Fallbrook Avenue, Suite 204
Fresno, California 93711
(559) 432 – 6847
ADF:adf